

Figure 22.1 The C-H Bonds in Methane

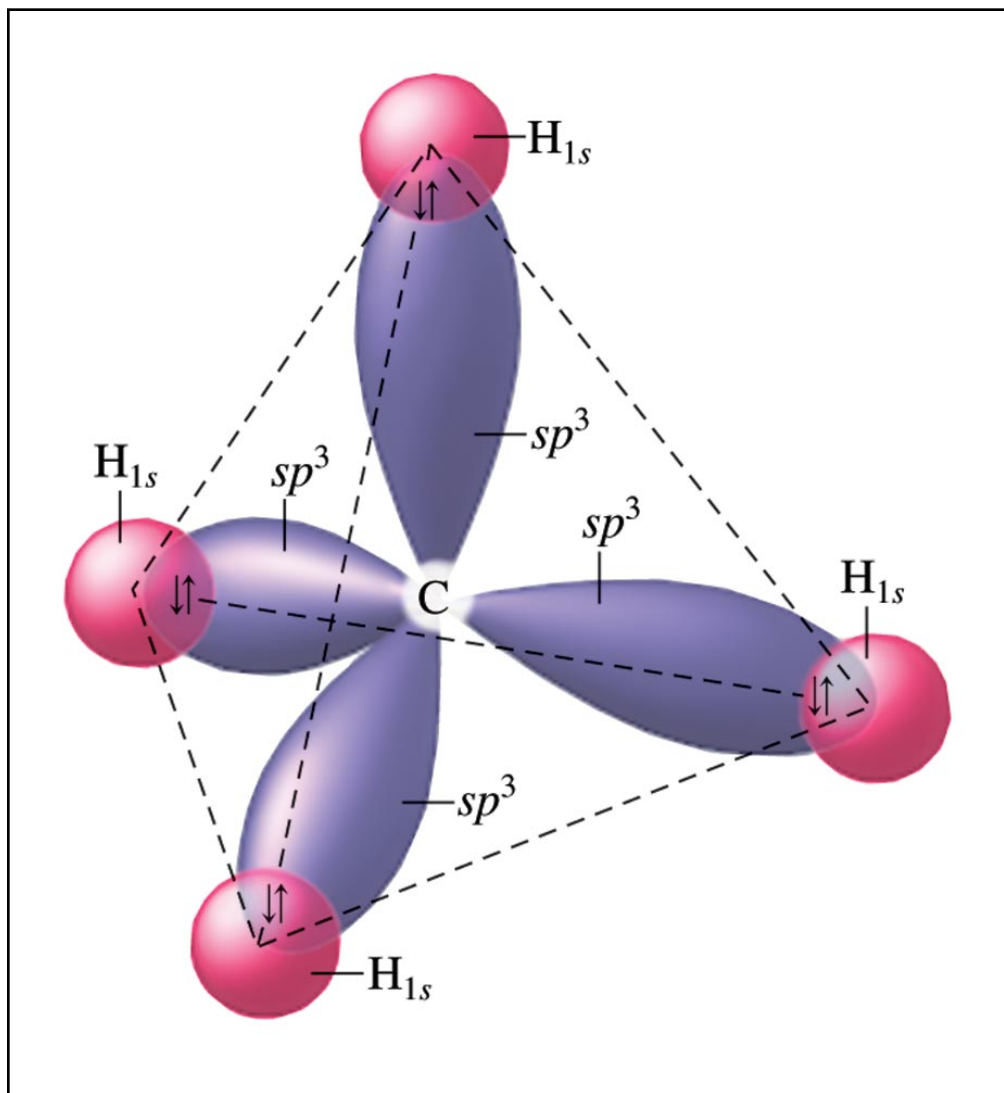


Figure 22.2
a-b (a) The
Lewis
Structure of
Ethane (b)
The
Molecular
Structure of
Ethane

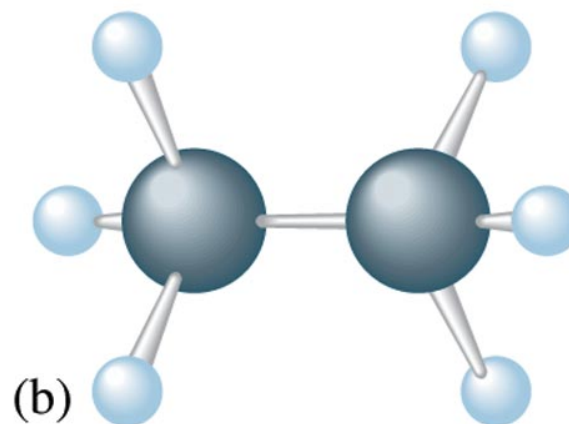
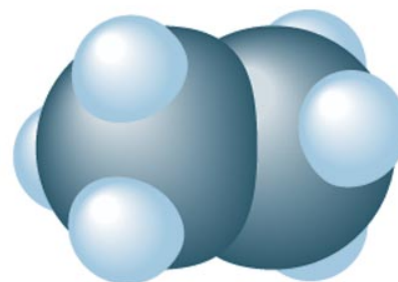
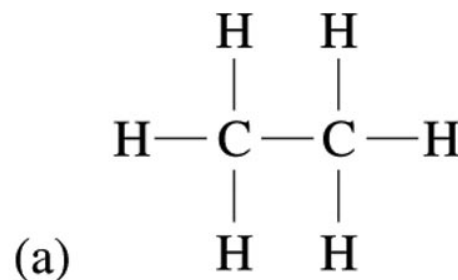
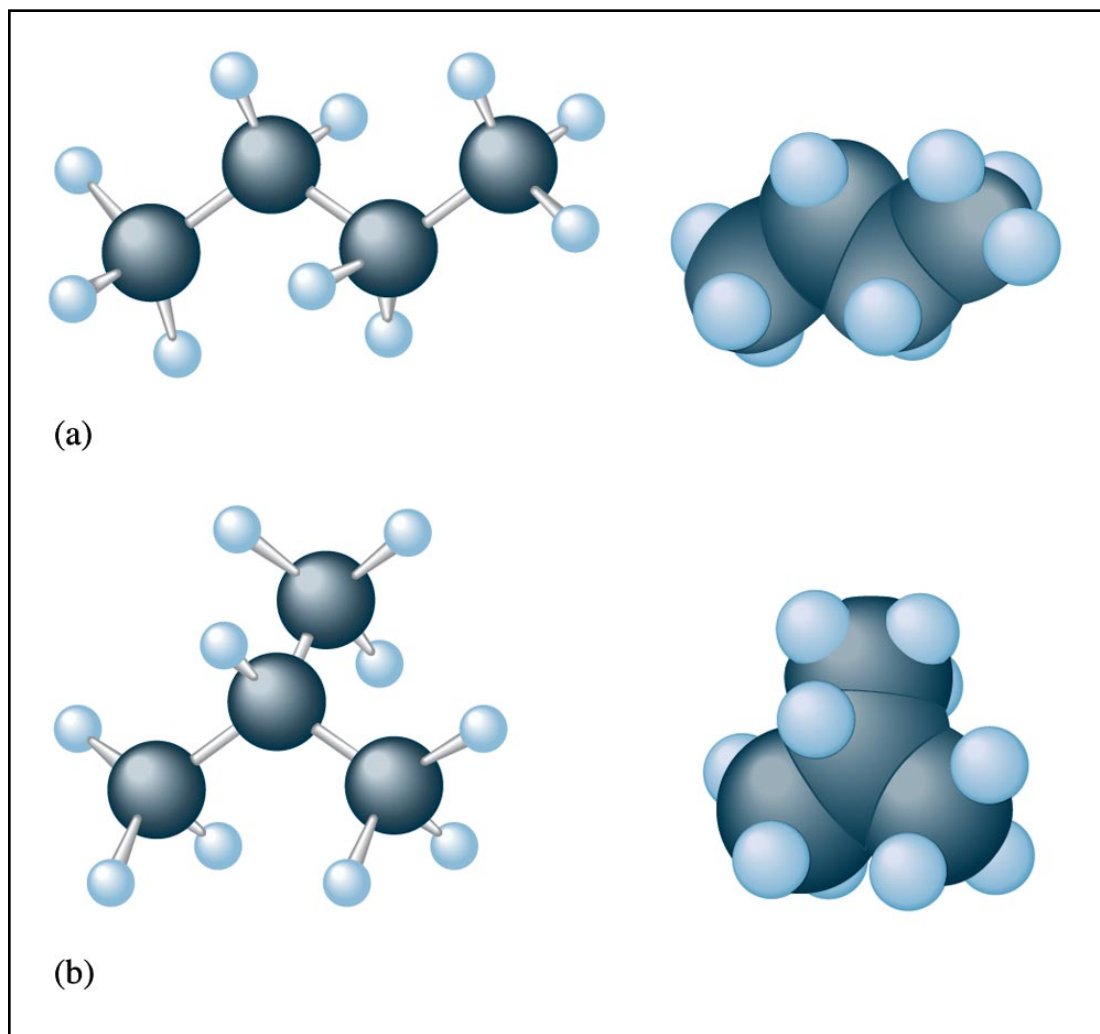


Table 22.1 Selected Properties of the First Ten Normal Alkanes

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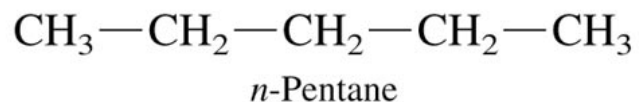
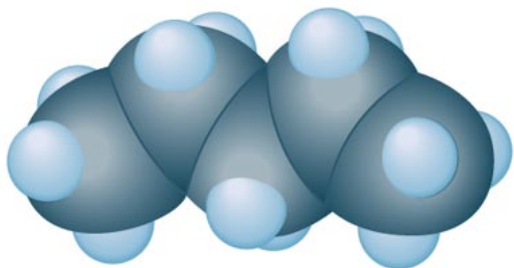
Name	Formula	Molar Mass	Melting Point (°C)	Boiling Point (°C)	Number of Structural Isomers
Methane	CH ₄	16	−182	−162	1
Ethane	C ₂ H ₆	30	−183	−89	1
Propane	C ₃ H ₈	44	−187	−42	1
Butane	C ₄ H ₁₀	58	−138	0	2
Pentane	C ₅ H ₁₂	72	−130	36	3
Hexane	C ₆ H ₁₄	86	−95	68	5
Heptane	C ₇ H ₁₆	100	−91	98	9
Octane	C ₈ H ₁₈	114	−57	126	18
Nonane	C ₉ H ₂₀	128	−54	151	35
Decane	C ₁₀ H ₂₂	142	−30	174	75

Figure 22.4 a-b (a) Normal Butane and (b) The Branched Isomer of Butane

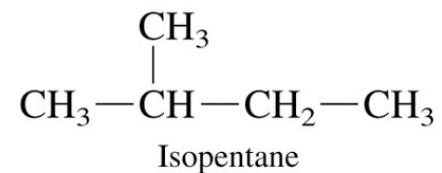
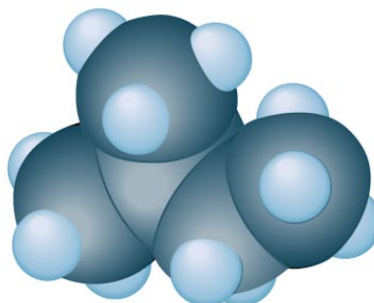


n-Pentane, Isopentane and Neopentane

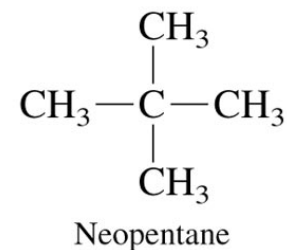
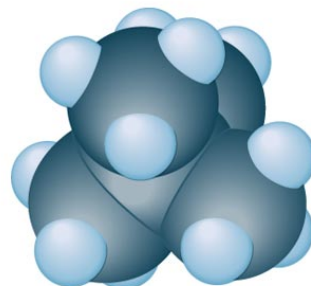
1.



2.



3.



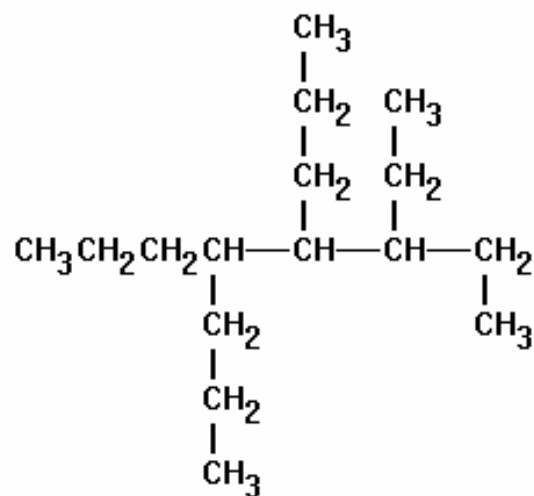
Naming Alkanes

1. The names of alkanes beyond butane are obtained by adding the suffix *-ane* to the numeric root. For a branched hydrocarbon, the longest continuous chain of carbon atoms determines the root name for the hydrocarbon.
2. When alkane groups are branches off a longer chain hydrocarbon compound, they are named by dropping the *-ane* and adding *-yl*. So -CH_3 is a methyl group.
3. The positions of the substituent groups are specified by numbering the longest chain H-carbon starting at the end closest to the branching. (want the lowest number of carbons)
4. The location and name of each substituent are followed by the root alkane name. The subs are listed in alphabetical order, and prefixes *di-*, *tri-*, etc. are used for multiple, identical substituents.

Draw the structure of 3-methyl-4-ethyloctane?

How many carbon atoms are present per molecule? How many of those are present on the side chains (branches) only?

Name the following alkane.



3-ethyl-4,5-dipropyloctane

Table 22.2 The Most Common Alkyl Substituents and Their Names

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Structure*	Name†
—CH_3	Methyl
$\text{—CH}_2\text{CH}_3$	Ethyl
$\text{—CH}_2\text{CH}_2\text{CH}_3$	Propyl
$\begin{array}{c} \\ \text{CH}_3\text{CHCH}_3 \end{array}$	Isopropyl
$\text{—CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$	Butyl
$\begin{array}{c} \\ \text{CH}_3\text{CHCH}_2\text{CH}_3 \end{array}$	<i>sec</i> -Butyl
$\begin{array}{c} \text{H} \\ \\ \text{—CH}_2\text{—C—CH}_3 \\ \\ \text{CH}_3 \end{array}$	Isobutyl
$\begin{array}{c} \text{CH}_3 \\ \\ \text{—C—CH}_3 \\ \\ \text{CH}_3 \end{array}$	<i>tert</i> -Butyl

*The bond with one end open shows the point of attachment of the substituent to the carbon chain.

†For the butyl groups, *sec*- indicates attachment to the chain through a secondary carbon, a carbon atom attached to *two* other carbon atoms. The designation *tert*- signifies attachment through a tertiary carbon, a carbon attached to *three* other carbon atoms.

QUESTION

What is the other product, besides HCl, in the following reaction?



Figure 22.5 a-b

(a) The
Molecular
Structure of
Cyclopropane
(b) The Overlap
of the sp^3
Orbitals that
Form the C-C
Bonds in
Cyclopropane

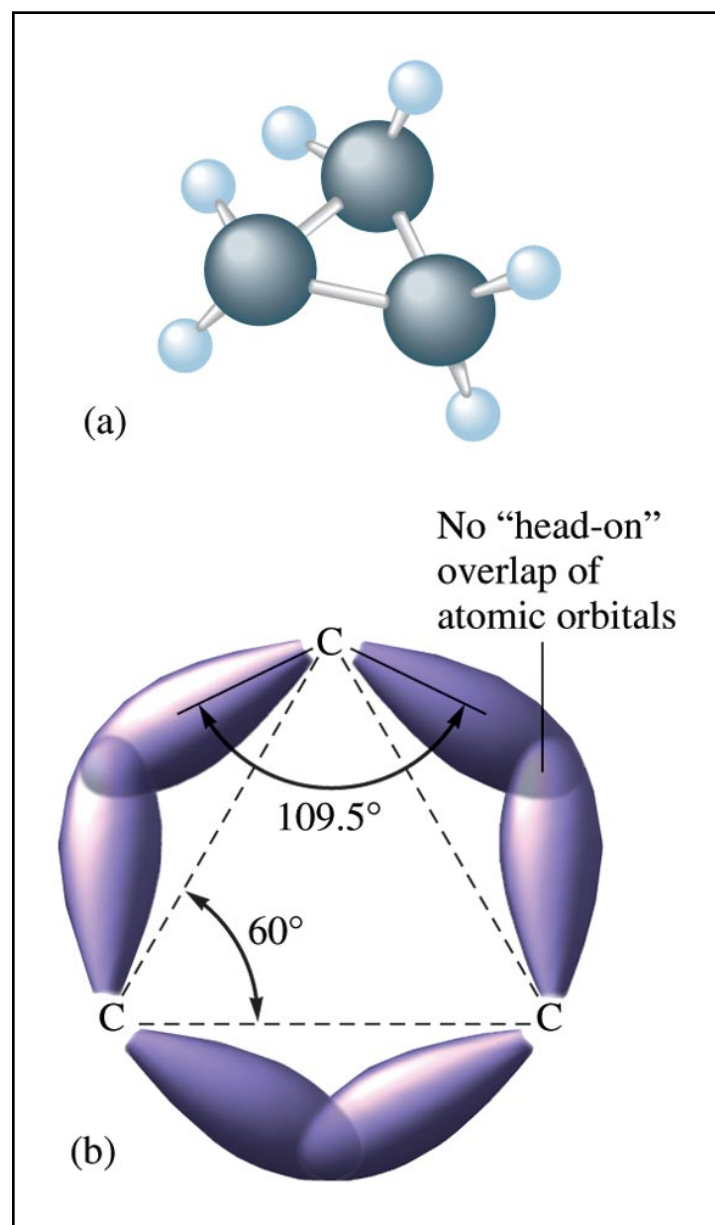
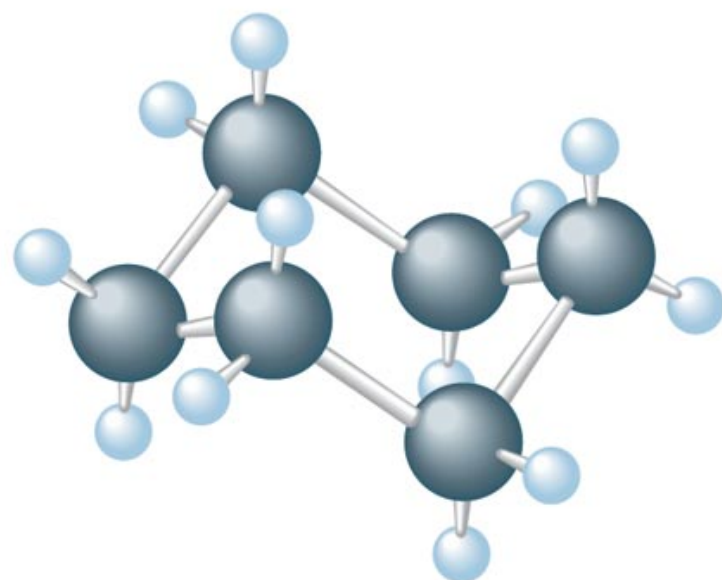
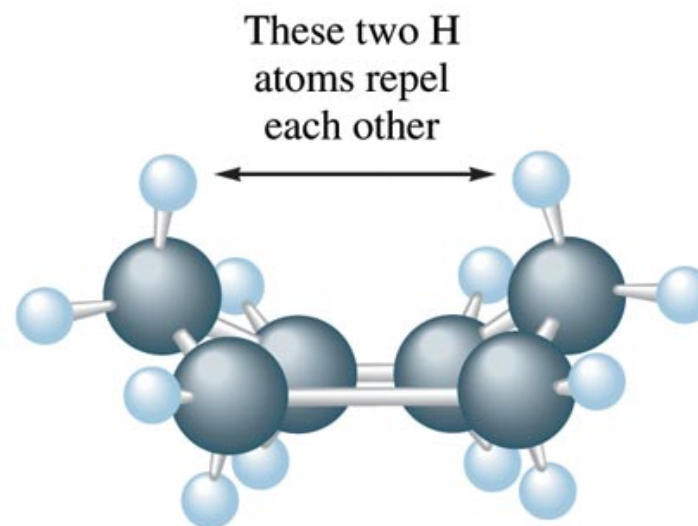


Figure 22.6 a-b The (a) Chair and (b) Boat Forms of Cyclohexane



Chair

(a)



Boat

(b)

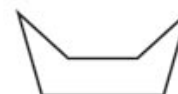


Figure 22.7 The Bonding in Ethylene

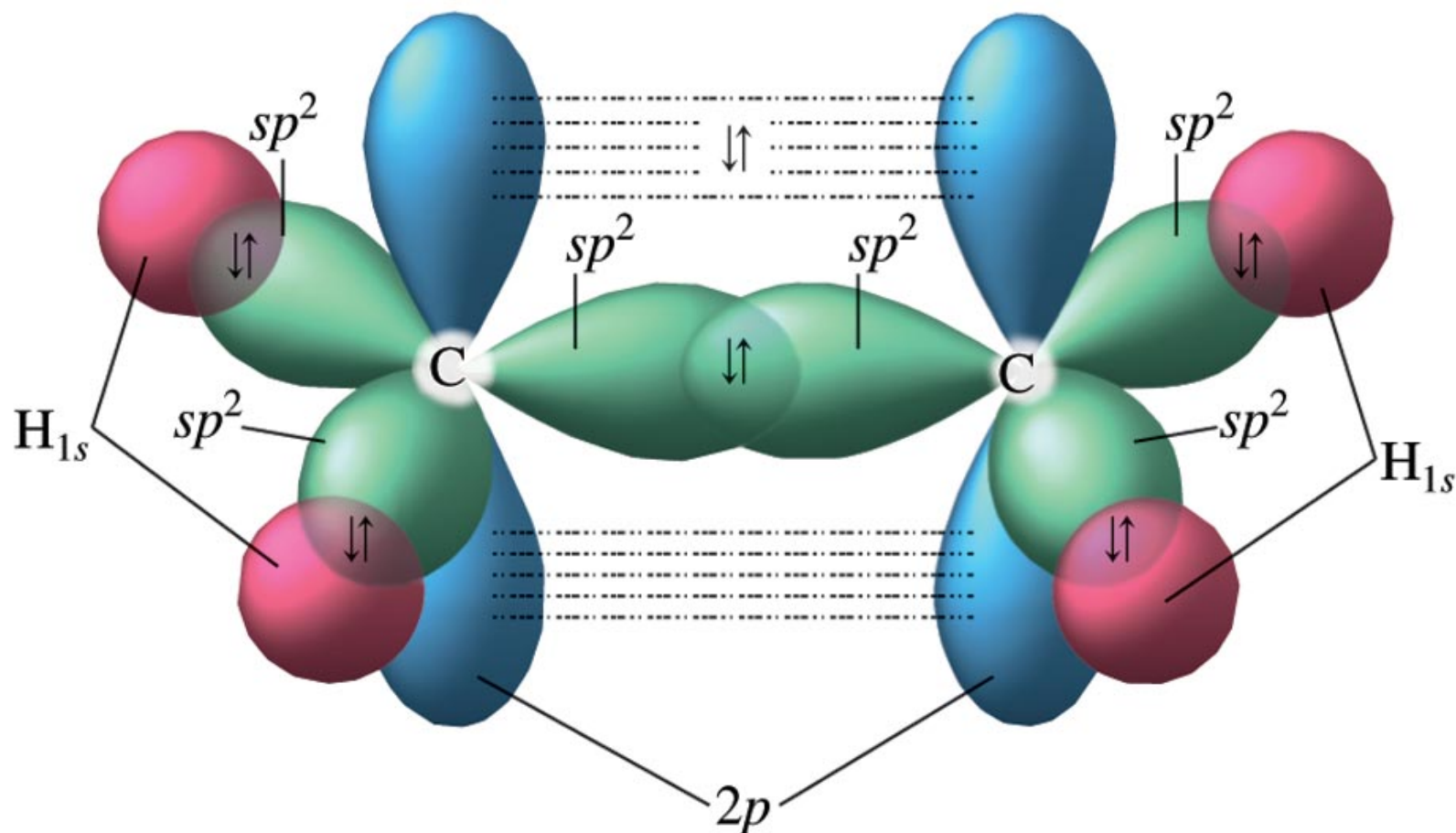


Figure 22.8 The Bonding in Ethane

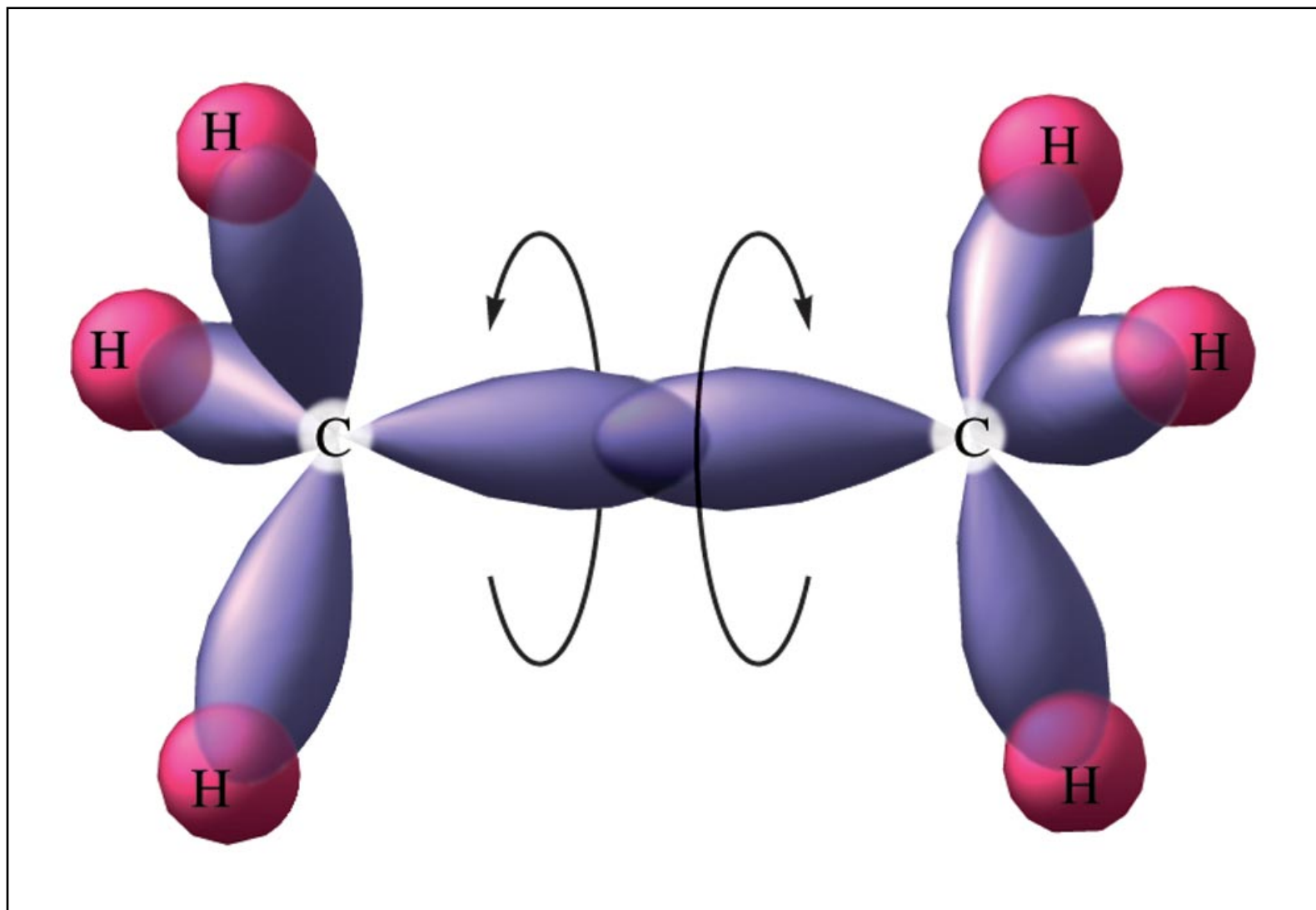


Figure 22.9
The Two
Stereoisomers
of 2-Butene:
(a) *cis*-2-
Butene and (b)
trans-2-Butene

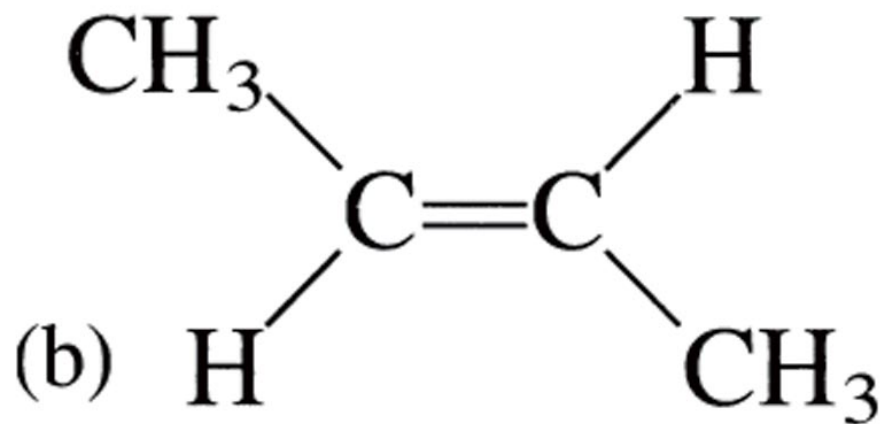
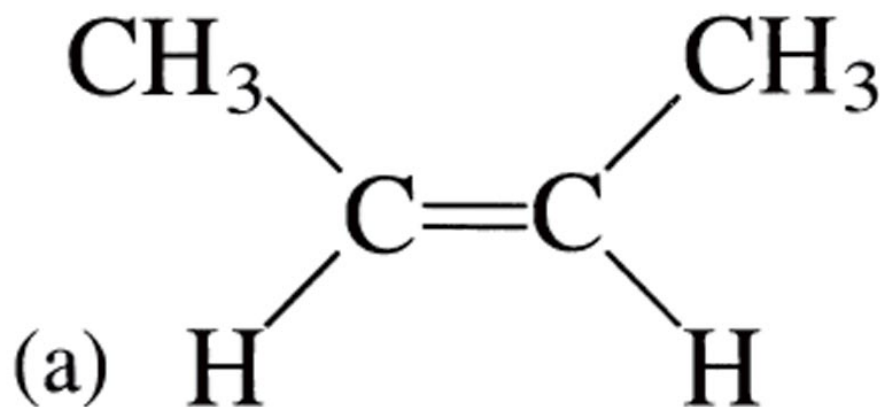
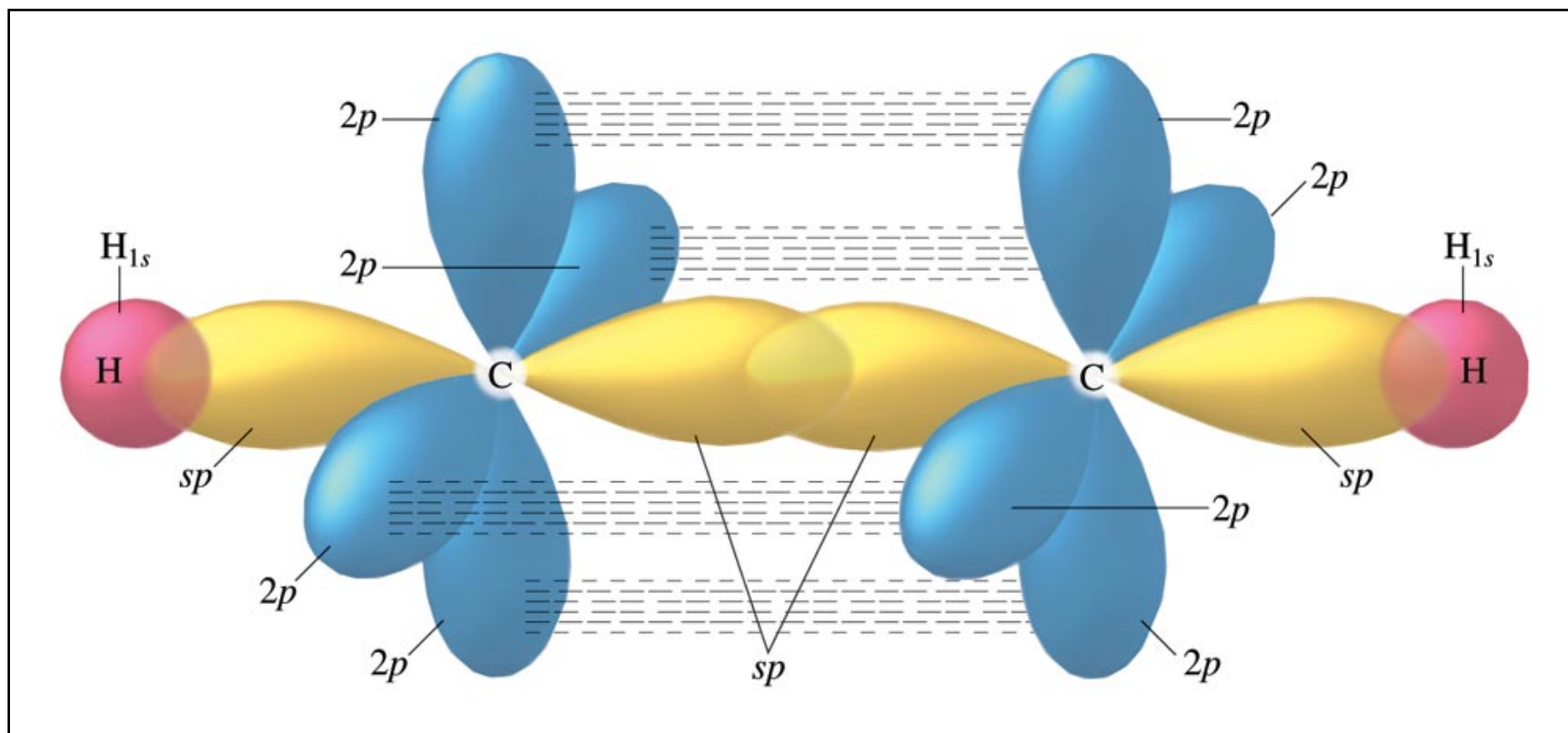
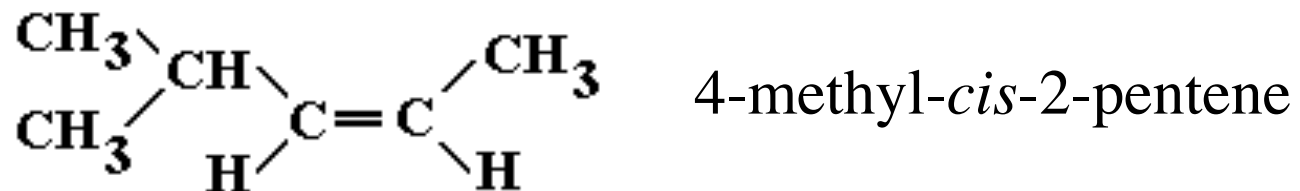


Figure 22.10 The Bonding in Acetylene



Name the following alkene.



Name the following alkyne.

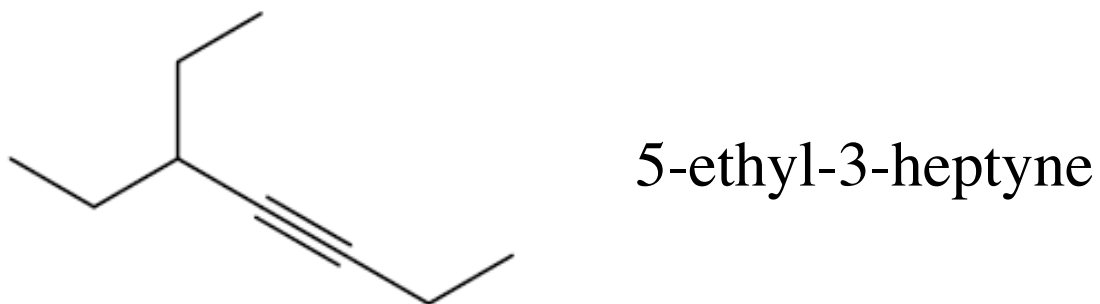
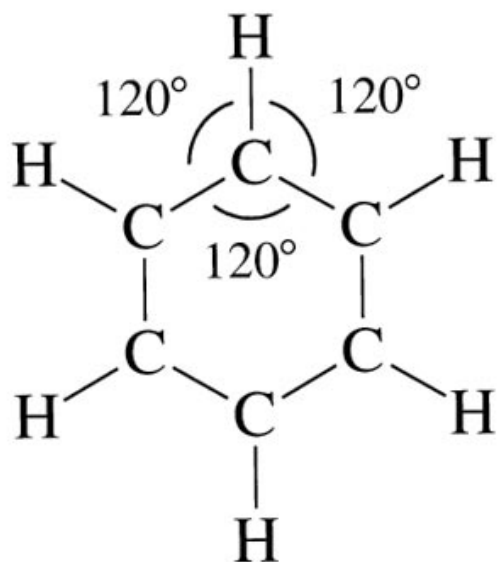
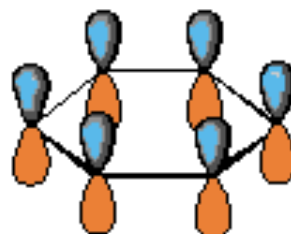


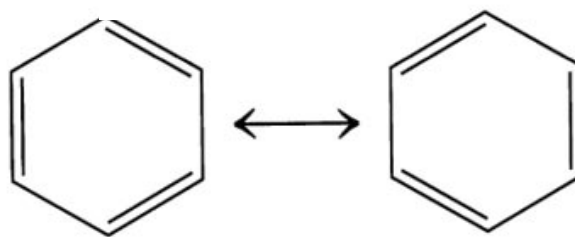
Figure 22.11 a-c (a) The Structure of Benzene (b) Two of the Resonance Structures of Benzene (c.) The Usual Representation of Benzene



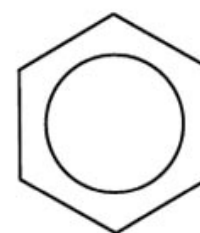
(a)



six 2p
atomic orbitals



(b)



(c)

Figure 22.12 Selected Substituted Benzenes and their Names

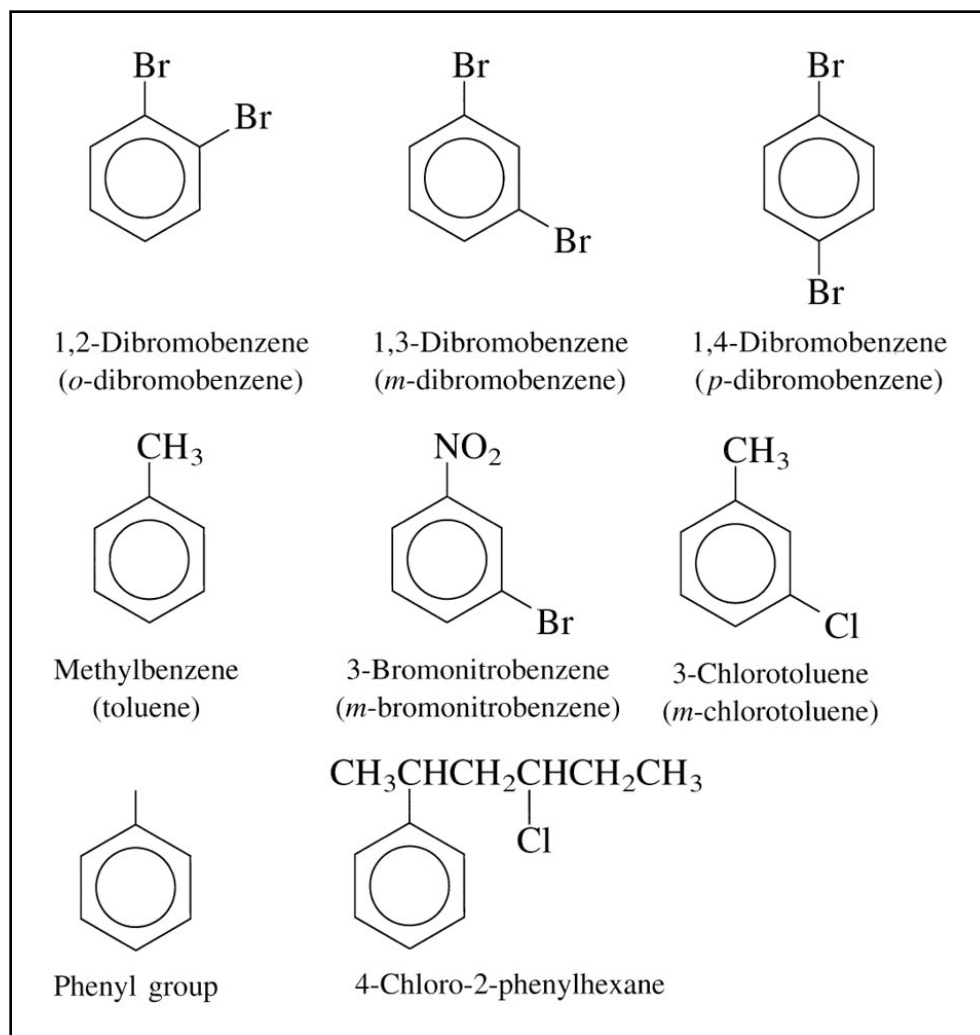


Table 22.3 More Complex Aromatic Systems

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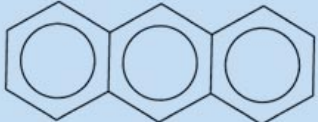
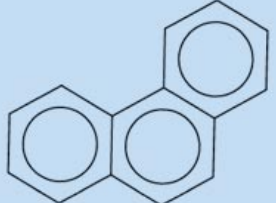

Structural Formula	Name	Use of Effect
	Naphthalene	Formerly used in mothballs
	Anthracene	Dyes
	Phenanthrene	Dyes, explosives, and synthesis of drugs
	3,4-Benzpyrene	Active carcinogen found in smoke and smog

Table 22.4 The Common Functional Groups

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Class	Functional Group	General Formula*	Example
Halohydrocarbons	$-\text{X}$ (F, Cl, Br, I)	$\text{R}-\text{X}$	CH_3I Iodomethane (methyl iodide)
Alcohols	$-\text{OH}$	$\text{R}-\text{OH}$	CH_3OH Methanol (methyl alcohol)
Ethers	$-\text{O}-$	$\text{R}-\text{O}-\text{R}'$	CH_3OCH_3 Dimethyl ether
Aldehydes	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{H} \end{array}$	CH_2O Methanal (formaldehyde)
Ketones	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}- \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{R}' \end{array}$	CH_3COCH_3 Propanone (dimethyl ketone or acetone)
Carboxylic acids	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{OH} \end{array}$	CH_3COOH Ethanoic acid (acetic acid)
Esters	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}- \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$	$\text{CH}_3\text{COOCH}_2\text{CH}_3$ Ethyl acetate
Amines	$-\text{NH}_2$	$\text{R}-\text{NH}_2$	CH_3NH_2 Aminomethane (methylamine)

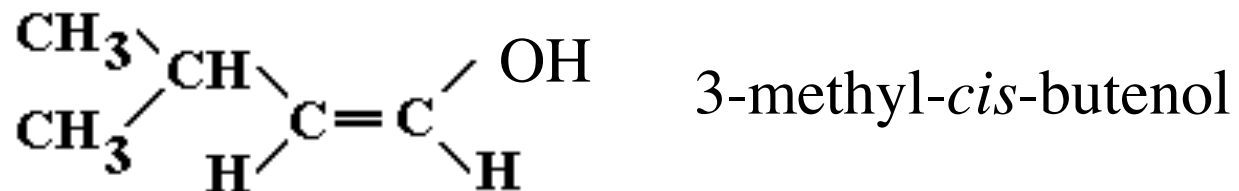
*R and R' represent hydrocarbon fragments.

Table 22.5 Some Common Alcohols

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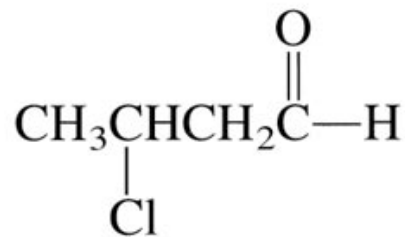
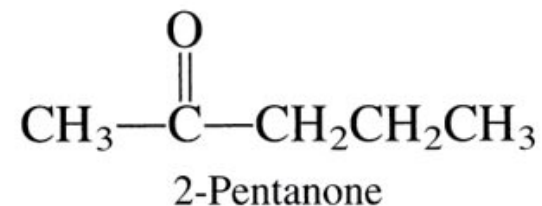
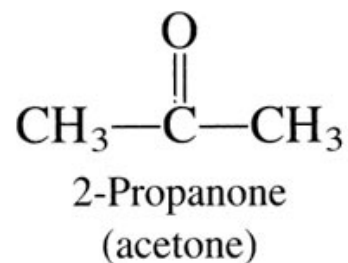
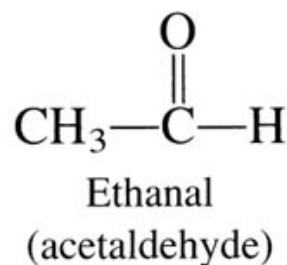
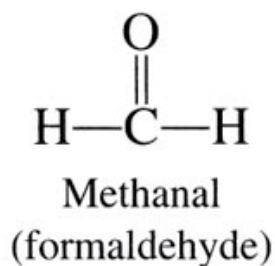
Formula	Systematic Name	Common Name
CH_3OH	Methanol	Methyl alcohol
$\text{CH}_3\text{CH}_2\text{OH}$	Ethanol	Ethyl alcohol
$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	1-Propanol	<i>n</i> -Propyl alcohol
$\begin{array}{c} \text{CH}_3\text{CHCH}_3 \\ \\ \text{OH} \end{array}$	2-Propanol	Isopropyl alcohol

Name the following alcohol.

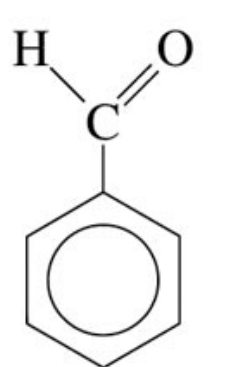


Draw the structure for 6-bromo-2-methyl-2-hexanol

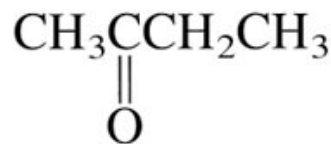
Figure 22.13 Some Common Ketones and Aldehydes



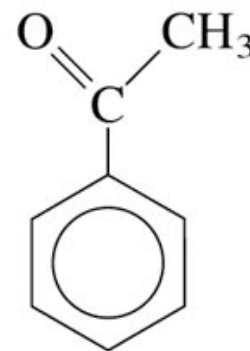
3-Chlorobutanal



Benzaldehyde



2-Butanone
(methyl ethyl ketone,
or MEK)



Methyl phenyl
ketone

Figure 22.14

Some Carboxylic Acids



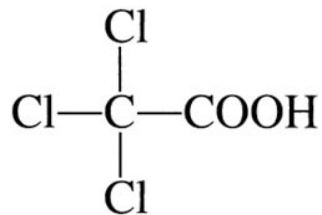
Butanoic acid



Benzoic acid



4-Bromopentanoic acid



Trichloroethanoic acid
(trichloroacetic acid)

Figure 22.15 The General Formulas for Primary, Secondary, and Tertiary Amines

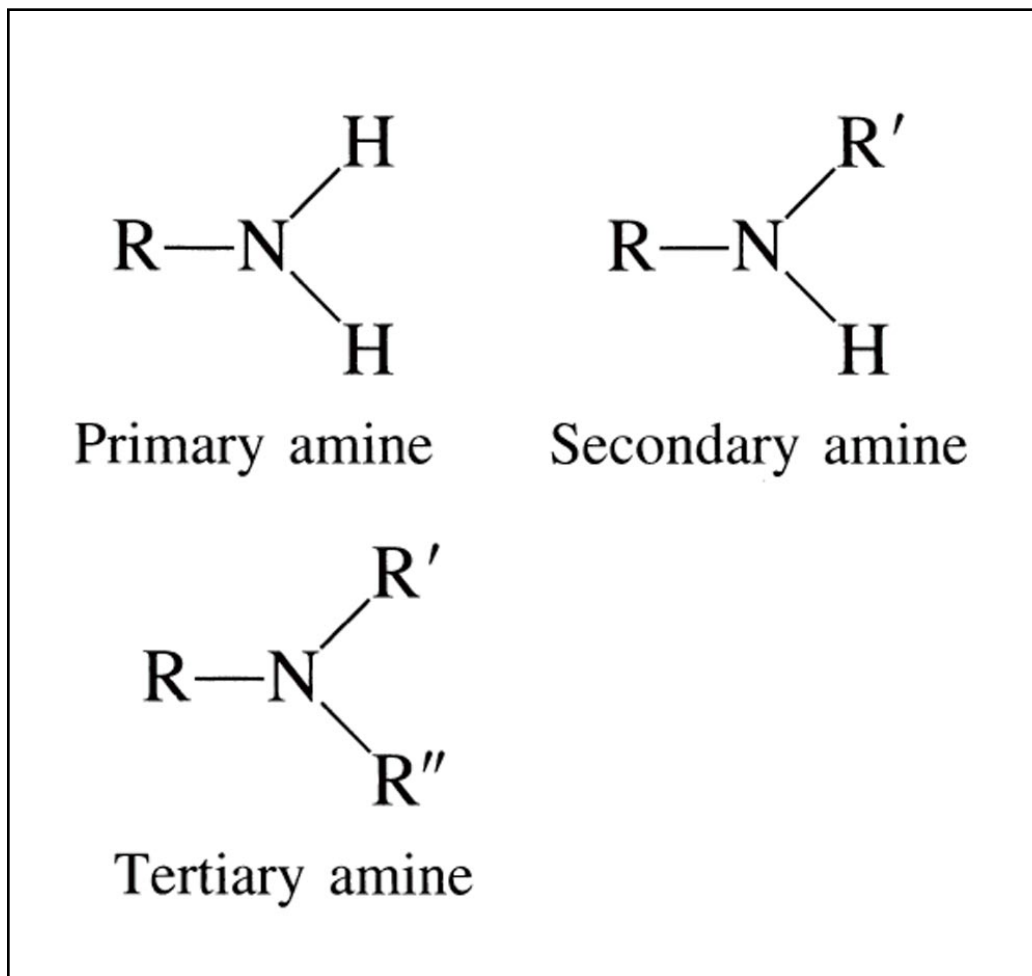
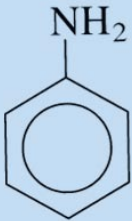
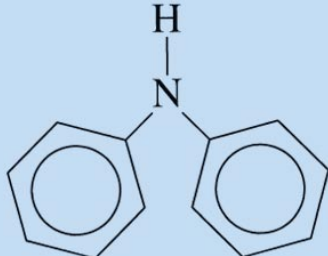


Table 22.6 Some Common Amines

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Formula	Common Name	Type
CH_3NH_2	Methylamine	Primary
$\text{CH}_3\text{CH}_2\text{NH}_2$	Ethylamine	Primary
$(\text{CH}_3)_2\text{NH}$	Dimethylamine	Secondary
$(\text{CH}_3)_3\text{N}$	Trimethylamine	Tertiary
	Aniline	Primary
	Diphenylamine	Secondary